

Appendix 2B-3: Continuing, Completed and New Research

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CONTINUING RESEARCH

The following section highlights recent research findings from various mercury-related projects.

Mercury Emissions from Mobile Sources

Obtaining source emissions information is critical in all types of atmospheric pollution investigations. One potential source of emissions of reactive gaseous mercury (RGM) not previously examined is the potential for emissions by mobile sources – gasoline or diesel-powered vehicles. Vehicular emissions of RGM result from oxidation of both mercury in the fuel and oil and oxidation of Hg⁰ in ambient air used in combustion. The objectives of this project were to develop mobile source signatures for automobiles and heavy diesels and to estimate the magnitude of mercury emissions rates from the two classes of vehicles. During September 1998, the Florida Department of Environmental Protection (Department) and the U.S. Environmental Protection Agency Office of Research and Development-National Environmental Research Laboratory (USEPA ORD-NERL) sponsored a collaboration between agencies and the universities of Miami, Maryland and Michigan to collect and analyze samples of tunnel air during the peak rush-hour periods. Samples were collected for volatile, semivolatile and particulate organic matter; elemental and volatilizable carbon; elemental, particulate and reactive mercury; and fine and coarse particle mass and trace elements. The study was conducted at the Interstate 95 Fort McHenry Tunnel complex near Baltimore, Maryland. Samples were collected for one week at three locations: at an ambient reference site above the tunnels, in a tunnel carrying primarily automobiles and in a second tunnel carrying primarily heavy diesel trucks. Data analysis is currently proceeding (Keeler, 2000) in the participating laboratories, and final project reports are due in early 2001.

Development of Improved Atmospheric Mercury Model

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The first serious attempt to model the national pattern of mercury emissions and deposition was conducted by the United States Environmental Protection Agency (USEPA) for the Mercury Study Report to Congress (Bullock et al., 1997; USEPA, 1997b) using the RELMAP model. At that time, the understanding of mercury speciation and its importance on the fate of emissions and deposition was just emerging. There were few speciated emissions data available and little or no ambient RGM data. Simplifying assumptions had to be made for the modeling to proceed. As described above in the section on Atmospheric Mercury Models, the limited scope of the SoFAMMS study allowed the application of finer resolution for South Florida, but still relied on general-purpose models, with limited detail in the representation of chemical and physical phenomena that influence mercury transport and fate.

In 1997, the Department, USEPA Region 4 and ORD agreed to jointly sponsor development of a more fully featured mercury-chemistry model designed to conform to the modular interface specifications of the modeling family being developed by USEPA, Models-3. The Atmospheric Chemistry Processor within Models-3 is the Community Multi-Scale Air Quality Model, or CMAQ. Models-3 and CMAQ allow specialized submodels to be developed for application within the modeling framework. CMAQ embodies detailed representations of the full atmospheric oxidant chemistry that has emerged from many years' research on acid rain, ozone and fine particulate matter by the atmospheric chemistry community at large. Given proper parameterization of processes and rates, the net of these reactions should describe the chemical transformations of mercury on local and regional scales. The University of Michigan Air Quality Lab was chosen to lead development of this CMAQ mercury submodel in concert with atmospheric scientists elsewhere within the university. Delays in the delivery of operable versions of CMAQ and its documentation have slowed progress on this project. Functional versions of the model are operating at UMAQL, and students from various departments are working on aspects of model development. Anticipated completion of this task is mid-to-late 2002.

Developing a bacterial biosensor for aquatic mercury (II) speciation and bioavailability

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and Paulo Barrocas

For mercury to be methylated to form MeHg, its most toxic and bioaccumulative form, it must be initially in a chemical form that can move through the cell membrane of the sulfate-reducing bacteria responsible for methylating mercury. In aquatic systems, the uptake of trace metals, including Hg(II), by microorganisms is governed by the redox and solution speciation of the metals. The chemical forms of the metals that can be classified as "bioavailable" are determined by the nature of the transport mechanism used by a particular organism for a specific metal. For dissolved copper, it is the free cupric ion (Cu^{2+}) that becomes toxic to microorganisms

at only moderately elevated levels (low micromolar). For iron, it is the free Fe^{3+} ion and labile complexes with inorganic ligands, such as chloride and hydroxide, which have proven to be bioavailable to phytoplankton. For both of these metals (and many other trace metals), complexation with natural dissolved organic ligands reduces the free metal concentrations to extremely low levels (picomolar) and protects microorganisms from the toxic effects of the metals. For mercury, recent research suggests phytoplankton and bacteria take in neutral inorganic complexes, such as HgCl_2^0 and HgS^0 , in addition to neutral Hg(II) complexes with low molecular weight organic ligands (Lawson and Mason, 1998; Benoit et al., 1998). The rate of production of MeHg by sulfate-reducing bacteria appears to be controlled to a large extent by the concentrations of these neutral Hg(II) complexes and their rates of passive diffusion into cells. As a result, the movement of Hg(II) into an ecosystem, and its bioaccumulation as MeHg in higher trophic levels, is strongly influenced by the first step in the sequence: the uptake of bioavailable forms of Hg(II) by bacteria. Understanding this critical step is limited by the lack of analytical methods that can accurately and rapidly detect the concentrations of bioavailable Hg(II) in natural waters. The ideal technique would be highly sensitive, would use small sample volumes and would have a response proportional to the concentration (or activity) of a particular Hg(II) solution species.

A sensitive and stable biosensor was reported by Virta et al. (1995), who coupled the *mer operon* with firefly luciferase enzyme expression in a common *E. coli* bacterium. This biosensor is easy to culture, and the light production in response to bioavailable Hg is far less impacted by the metabolic state of the bacterium. In their research, they found a linear response between Hg(II) exposure and light production from levels as low as 0.1 femtomolar (0.02 pg/L) to as high as 100 ng/L. In their experiments, detectable light emission was quantified using as little as 100 μL of Hg(II) solution; the technique, as published, should prove useful for analyzing Hg bioavailability on small-volume samples, such as those obtained from pore water sampling.

Initial experiments centered on the calibration of the biosensor bacteria versus Hg(II) solutions of known (modeled) speciation. In the second year during the third year of the project, Hg(II) bioavailability will be tested in natural water samples collected from Florida lakes and rivers, as well as from the Everglades, in conjunction with ongoing research projects. Samples from the Florida Everglades will be collected in collaboration with the ACME research group, including Cindy Gilmour and Dave Krabbenhoft.

The benefits of this research include improvement of the Everglades Mercury Cycling Model so better predictions can be made of the response of the ecosystem to altered mercury loads and management practices. This research has concentrated on developing the methodology for quantifying mercury species bioavailability. This research will be finalized at the end of 2002.

Evaluation of advanced treatment technologies for mercury effects

Peter Rawlik and Larry Fink

The Department and District are conducting studies to evaluate the potential effectiveness of various Advanced Treatment Technologies (ATTs) to remove phosphorus from Everglades Agricultural Area runoff in the low concentration range at or below the design TP target of 10 ppb. Potential effects of the STAs and ATTs on the formation of MeHg are also being evaluated as a component of the STA and ATT research. This work is being co-funded by USEPA Region 4 via a Clean Water Act Section 319 grant managed by FDEP.

Particular consideration is being given to potential effects of periphyton-based STAs and chemical addition of compounds that might promote mercury methylation or exacerbate bioaccumulation. The transformation of mercury into MeHg appears to be carried out by anaerobic sulfate-reducing bacteria (SRB) (Gilmour and Henry, 1991). In the Everglades and associated ecosystems, there are three microhabitats that appear to be capable of supporting SRB: the sediment/water interface (Gilmour et al., 1998), the extensive periphyton mats (Cleckner et al., 1999) and the root zones of floating macrophytes, such as water hyacinth and water lettuce (Hurley et al., 1999). Consequently, any ATT that uses sediments, periphyton or floating macrophytes might potentially provide areas for increased mercury methylation. Additionally, any ATT that affects the concentration of sulfur and/or impacts the sulfate-sulfide ratio might also provide opportunities for increased mercury methylation.

Several ATTs are being evaluated for their effectiveness in removing phosphorus and their effect on MeHg concentrations. An example is Chemical Treatment and Solid Separation, a technology that uses iron or aluminum salts in combination with a variety of mixing and solids separation devices to remove phosphorus. This technology was tested at two pilot plants: one upstream of STA-1 West near the inflow, and one downstream of the project at the outflow. The upstream sites used iron sulfate, while the downstream site used aluminum sulfate. Samples were collected weekly from the inflow, discharge and sludge following District protocols for the collection of ultratrace total mercury (THg) and MeHg. The filtered and unfiltered inflow and discharge samples were analyzed for THg and MeHg. Results indicate that the CTSS technology did not appear to elevate MeHg concentrations in the discharge. Additionally, based on the crude mass balance the technology did not appear to transform THg into MeHg in the residuals. Therefore, this technology does not appear to increase mercury methylation rates. Additional ATTs are scheduled for testing over the next several years. These studies will also be co-funded by USEPA Region 4 under the Section 319 grant.

Uptake of Methylmercury by Algae

Anson Moye, Carl Miles and Ed Philips

Uptake of MeHg by algae is the first mercury bioconcentration step in most aquatic food webs and it is the step with the highest bioaccumulation factor. The amount of MeHg in the algae cytoplasm is also important because it has been shown that the cytoplasm is the portion transferred up the trophic chain (Mason et al., 1995). Mercury models, such as the Everglades Mercury Cycling Model (E-MCM) (Hudson et al., 1994), require quantification of the amount of MeHg transferred from water to phytoplankton and the mechanism of uptake. The goal in Phase 1 of this research, which has been completed, was to provide this information. The goal in Phase 2 is to describe the mechanism, determine uptake rates and investigate the effects of sulfide and dissolved organic carbon (DOC) on uptake rates.

In Phase 1, phytoplankton-water partition constants (K_{pl}) for MeHg were determined in the laboratory for two green algae, *Selenastrum capricornutum* and *Cosmarium botrytis*, and the blue-green algae *Schizothrix calcicola*. Three methods, the Freundlich isotherm, a flow-through/dialysis bag and the diluted-algae method, were used to determine K_{pl} . The Freundlich-isotherm and the flow-through/dialysis-bag methods yielded K_{pl} of $10^{6.6}$, while K_{pl} was $10^{7.3}$ for the diluted-algae method. The K_{pl} for MeHg and *S. capricornutum* (exponential growth) was not significantly different in systems with predominantly MeHgOH or MeHgCl species. Partitioning constants, determined with exponential, stationary and phosphorus-limited, stationary phase cells at the same conditions, were not significantly different. This is consistent with other studies that show metal speciation controls uptake kinetics, but the reactivity with cellular components controls steady-state concentrations. Apparently, these cellular components were not affected by the different experimental parameters chosen here. The K_{pl} for *Cosmarium botrytis* ($10^{6.7}$) was similar to *S. capricornutum*, while the K_{pl} for *Schizothrix calcicola* was significantly lower ($10^{6.3}$). If partition constants are determined as volume-to-volume concentration factors (VCF), then VCF increases as the cell size decreases. This agrees with theoretical models that small phytoplankton cells accumulate more MeHg than larger cells.

The second component of our Phase 1 goals, a description of the mechanism of uptake, has provided preliminary information for Phase 2 work. Our kinetics data from Phase 1 used the disappearance rate of MeHg in water to infer algae concentrations. This is an introduced error that can be eliminated by using short-duration uptake of ^{14}C MeHg directly into algae (used now). Phase 1 kinetics experiments showed a weak correlation of MeHg uptake rate into algae with changing D_{ow} , suggesting that passive mechanism is not the dominant mechanism. However, experimental reproducibility was questionable. Results from this research, and the experience of others (Croot et al., 1999), show that determination of surface areas and culturing viable and bacteria-free algae is not a trivial task. This has slowed both the exploration of uptake into other species and the testing of uptake mechanisms over a wide range of species. Preliminary work with *Cosmarium* and *Schizothrix* is near completion and will answer the question of whether the partitioning and kinetic processes observed so far are general or specific for the type of algae.

Hypotheses being tested in Phase 2 include:

1. MeHg uptake by algae occurs primarily via passive diffusion
2. Sulfide and DOC inhibit the bioavailability of MeHg to phytoplankton
3. Active uptake of MeHg by algae is small or insignificant

Everglades Mercury Cycling Model Modification and Application

Curtis D. Pollman and Reed Harris

The Everglades Mercury Cycling Model (E-MCM) was developed under a subcontract from USEPA ORD, Environmental Research Laboratory, Athens, Georgia. In its form as prepared for the USEPA, it was a spatially simple but conceptually complex model of mercury biogeochemistry adapted to a wetland environment. In that form, the water chemistry for species other than mercury was defined by the user for each physical compartment. This was not adequate for management-relevant applications to the Everglades mercury problem in the context of the Everglades Construction Project (ECP; phosphorus removal from EAA waters) or the reconfiguration of the South Florida water management system under the Federal Restudy (hydropattern restoration). This E-MCM will be used to predict changes in localized and downstream water quality associated with the various restoration alternatives, both with and without reductions in loadings from local and regional mercury atmospheric sources.

To allow the E-MCM to predict the consequences of various restoration alternatives on Everglades mercury concentration and bioaccumulation, modifications must be made to the model. The required modifications to the time-dependent E-MCM model are occurring in phases. Phase 1 modifications incorporated changes to the E-MCM input format structure to facilitate the linkage of the E-MCM to other models to make the E-MCM more readily applicable to problems involving changes in total phosphorus loads to filter marshes and downstream receiving waters. Phase 1 was completed in 1999. Phase 2 modifications will incorporate directly into E-MCM the ability to simulate sulfur dynamics using a coupled mass balance-thermodynamic approach. In addition, E-MCM will be modified during Phase 2 to change its representation of bioenergetics and trophic level interactions to accommodate a “bottom-up” approach.

Another pending enhancement of the E-MCM is incorporation of a Monte Carlo simulation routine to allow for more rigorous analysis of uncertainties in the model outputs. One goal of the present TMDL Pilot Study for Atmospheric Mercury is to fully evaluate the uncertainties inherent in concatenating models of atmospheric cycling, aquatic cycling and food-web dynamics. Uncertainty and sensitivity analyses of model performance should identify information or understanding gaps in the present model formalism, and guide future research to improve model representation of sensitive processes.

Coupled with the Phase I modifications, the changes resulting from Phase 2 will make E-MCM more readily applicable to problems involving changes in phosphorus and sulfur loadings and to water quality standards development.

Speciated atmospheric mercury profiling experiment (SAMPEX)

Matthew Landis, Robert K. Stevens
and Gerald Keeler

One of the policy-relevant questions that has been difficult to assess is the potential for long-range transport of mercury from sources around the globe to contribute to mercury deposition in South Florida. To the extent the “reactive” forms of mercury are brought over Florida by the easterly trade winds during the summer, when approximately 85 percent of rainfall mercury deposition occurs, this would lessen the effectiveness of any controls applied to emissions within the region. For example, if 50 percent of the RGM passing over the Everglades was from the global background and 50 percent was from local sources, the benefit of a 50-percent cut in local emissions would be no more than a 25-percent reduction in deposition. The point of diminishing returns on emissions controls within the region would be reached quickly.

Several hypotheses have been offered to suggest that long-range transport may be significant. The first was proposed by investigators of the Florida Atmospheric Mercury Study conducted in Florida from 1993 through 1996. Drs. Guentzel and Landing measured wet and bulk deposition of mercury at nine sites in Florida, seven of which were in South Florida and four adjacent to the Everglades. Rainfall samples were also analyzed for trace element constituents.

Using multivariate statistical techniques, the investigators found little correlation between rainfall mercury and trace elements indicative of sources, such as municipal waste incineration, and concluded that in the absence of such associations local source contributions must necessarily be small (Guentzel, 1997). It is the view of some observers, however, that this lack of correlation was not conclusive because the protocol for FAMS was to collect monthly integrated rain samples, which often resulted in the mixing of a number of rainfall events thereby obscuring trace element relationships. The second hypothesis suggesting a potentially significant contribution of RGM from marine air masses is that of the potential role of marine aerosol-derived reactive halogen species in the marine boundary layer. The existence and potential importance of marine halogen species was proposed by Keen et al. (1990) and remains a subject of active investigation. Determination of the rates of this type of reaction and its potential significance in contributing a source of non-anthropogenic mercury to the United States is one of the key questions raised by staff and reviewers at the recent peer review workshop on the EPA Mercury Research Strategy.

Recent papers by Dickerson, et al. (1999) and Knipping, et al. (2000) suggest that the presence of free halogen oxidant species in the temperate marine boundary layer can be significant. The recent finding that the sulfide mercury reduction pathway (Van Loon, et al., 2000) is effectively several hundred-fold slower than previously assumed, which was an important constraint in atmospheric chemistry models and heightens the importance of the question of chlorine and bromine oxidation reactions in the marine air. Arguing against the potential importance of this hypothesized halogen oxidation with respect to Florida is the estimated atmospheric half-life of elemental mercury of one-to-two years. The upper bound of any major reaction pathway is constrained by the inverse of this half-life, i.e., a global average total oxidation rate of ~0.1 to 0.3 percent per day. As discussed in the Background section of this document, given that the half-life of a soluble reactive species in the marine boundary layer would be about one day, only mercury oxidized in a short transit time would have the potential to impinge on Florida; mercury oxidized farther away would be deposited before reaching Florida.

Given the paucity of knowledge about the atmospheric reaction pathways of mercury and their rates, present global models are too crude to constrain the potential impacts of marine air masses on coastal areas.

In an effort to provide information that would aid in constraining this question, the SAMPEX project was conceived to make direct measurements of mercury species at various altitudes over the Atlantic Ocean east of Florida during the period when easterly trade winds advect large amounts of marine air across Florida. A collaborative project between the USEPA Office of Research and Development and Region 4, NOAA Air Resources Laboratory, the Department, Broward County Department of Planning and Environmental Protection, Air Quality Division (DPEP) and the University of Michigan Air Quality Laboratory was developed to plan and conduct an airborne measurement campaign. The NOAA ARL Twin Otter aircraft was equipped with its atmospheric research package consisting of sophisticated equipment and data systems for measuring pollutant gases and particles. This equipment was augmented by the Department and USEPA-designed mercury speciation equipment to measure elemental, reactive and particulate-associated forms of mercury.

Twenty flights were conducted during January and June 2000, and excellent operational results were obtained. Equipment reliability and data capture were excellent. Two high temporal frequency ground-based monitoring sites were operated during the summer intensive in 2000, one at a beach site and one at a site near the eastern boundary of the Everglades. Sample analysis of the variety of samples collected in SAPEX continues. Energy Dispersive X-Ray Fluorescence (EDXRF) analysis of the composition of fine particulate samples has been delayed by equipment limitations at the USEPA NERL Laboratory. USEPA is seeking to have its older generation equipment repaired, is testing commercial instruments available and is in discussions with the Lawrence Berkeley Laboratory to design and build a new generation of XRF analyzers. Presuming that the older LBL instrument can be put back into production, the backlog of XRF analyses of particulate samples should abate within a few months.

Speciated Atmospheric Mercury Study (SAMS)

Matthew Landis, Robert K. Stevens
and Ken Larson

This project is named in recognition of the importance speciation of mercury in the atmosphere plays in controlling its transport and fate. SAMS makes highly time-resolved measurements of all known forms of atmospheric mercury and of associated tracer species. Since the last report, the Department and Broward County Department of Planning and Environmental Protection, Air Quality Division, have successfully established and operated two intensive air-monitoring sites in Broward County.

A secondary goal is to extensively field test advanced mercury monitoring equipment in an operational environment to define its performance characteristics, limitations and needed improvements in instruments or procedures. This project should be viewed as a continuation of the program of atmospheric mercury research conducted by the Department, the USEPA and other collaborators on ancillary atmospheric tracer species and mercury deposition to address questions about the sources of mercury to the eastern boundary of the Everglades.

This project is meeting its objectives on operational reliability and should continue for two additional years.

COMPLETED RESEARCH

Florida Everglades Dry Deposition Study (FEDDS)

Gerald Keeler, Steven Lindberg, Frank Marsik,
Hong Zhang, Matthew Landis, Elizabeth Malcom and
Robert K. Stevens

Initial studies of the atmospheric sources of mercury focused on rainfall deposition and measurements of particulate-associated mercury in the atmosphere. With the appreciation of the importance of RGM as the controlling factor in mercury deposition, the potential importance of dry deposition of gaseous forms of mercury emerged as a critical unknown. The Florida Everglades Dry Deposition Study (FEDDS) was conceived by its principal investigators at the Oak Ridge National Laboratory (Dr. Steven Lindberg) and UMAQL (Dr. Gerald Keeler) as an intensive study to improve our understanding of the processes of mercury dry deposition. Its objectives were to provide information to improve the representation and parameterization of dry deposition in atmospheric models and to make deposition estimates to serve as validation checks on the models applied. FEDDS was funded by USEPA Region 4 and the Department, with invaluable in-kind support from the District. FEDDS field intensives were conducted in February and March 1998 and June 2000.

NEW RESEARCH

Mesocosm Studies to Quantify How Methylmercury in the Everglades Responds to Changes in Mercury, Sulfur and Nutrient Loading

Cynthia C. Gilmour and David P. Krabbenhoft

In 1994, a consortium of agencies began a study of the factors contributing to the high levels of Hg in Everglades biota. The Aquatic Cycling of Mercury in the Everglades (ACME) Project's overall objective has been to understand Hg cycling well enough to create management strategies that will minimize MeHg bioaccumulation in the Everglades while fulfilling other management objectives, such as nutrient reduction and hydropattern restoration.

Methylmercury production appears to be favored in wetlands and impounded wetlands, which can produce MeHg (e.g., Krabbenhoft et al., 1995; Branfireun et al., 1996; Gilmour et al., 1998; Heyes et al., in prep.) in quantities that may ultimately lead to elevated fish MeHg concentrations (Cleckner et al., 1998; Krabbenhoft et al., in prep). High rates of microbial MeHg production, driven by high organic matter inputs and flows of nutrient-bearing water, are the probable cause. The ACME project has focused on the processes that lead from atmospheric deposition of Hg to MeHg formation and bioaccumulation.

Key findings of the ACME Project, to date, include:

1. The spatial MeHg pattern is not driven primarily by total Hg concentration
2. Sulfur has a large impact on MeHg production

Methylation is rapid in certain types of periphyton (Cleckner et al., 1999); however, methylation in surface sediments appears to be the dominant source of new MeHg.

To model the potential effects of Everglades restoration efforts on Hg cycling, the relationships between sulfur, nutrient and Hg loading and MeHg production and bioaccumulation need to be separately and better quantified. The next phase of this research will quantify these individual relationships and the interactions among these three key parameters through amendments of Hg, S and nutrients, individually and in combination, to in situ mesocosms.

Stable Hg isotope amendments are proposed to examine the relationship between Hg loading and MeHg production and bioaccumulation. This new approach will track the fate of newly deposited Hg separately from the larger existing pools, and track the bioavailability of new Hg over time. The use of individual stable Hg isotopes allows the research to follow the cycle of new Hg added to the system, from initial partitioning, accumulation in vegetation, MeHg production and accumulation in sediments, fluxes and accumulation in the food web. The investigation will also be able to trace burial, post-depositional reworking of Hg through sediments and plants and Hg₀ formation. Stable isotopes will allow the study to address the changes in phase speciation of newly deposited Hg over time, the relative availability of new Hg for methylation as phase speciation changes, bioavailability from decaying plant material relative to sediments for methylation, and the recycling of buried Hg to the sediment surface through plant growth and decay.

Using stable Hg isotope amendments and Hg, sulfur and nutrient amendments to mesocosms, the following questions will be addressed:

- How will changes in Hg loading affect the magnitude and spatial distribution MeHg production and bioaccumulation in the Everglades?
- How will changes in sulfur loading affect MeHg production and bioaccumulation in the Everglades?
- How will changes in nutrient loading affect MeHg production and bioaccumulation in the Everglades?
- How do these stressors interact to affect MeHg production and bioaccumulation?
- How do the effects of these stressors change across the trophic gradient of the Everglades?

Chemical Transformations of Mercury in the Atmosphere

Chester Spicer

The Department and USEPA Region 4 have identified funds and budgeted for additional studies of the reaction mechanisms or pathways that convert Hg^0 to the oxidized forms (i.e., reactive) in the atmosphere. Using advanced mass-spectroscopic techniques, the proposed research will measure the homogeneous gas-phase reaction rates and products of the transformations of mercury by Hydroxyl Radical (OH^\cdot), Hydroperoxy Radical (HO^2), molecular Bromine and molecular Chlorine. Completion of these experiments is anticipated in the third quarter of 2001.

Trend Analyses of Mercury in Florida, With an Emphasis on South Florida

Declines were observed in incinerator emissions of mercury in South Florida, beginning in the mid-1980s. Subsequently, there was an apparent decline in mercury in Everglades fish and wildlife in the mid-1990s. The apparent lag time between the onset of emissions reduction and the decline in mercury concentrations in fish and wildlife is consistent with the predictions made by the Everglades Mercury Cycling Model. There is, however, contradictory evidence in that the atmospheric deposition data collected from 1995 to the present (and continuing) show no downward trend. This apparent paradox might have a logical resolution that lies in better reconstruction of the recent history of the magnitudes of emission and deposition of mercury in South Florida. The Department, in coordination with the Florida Electric Power Coordinating Group, will be funding a series of projects to examine the trends in these data in detail. Each element of these analyses is briefly discussed below.

Material Flows Analysis of Historical Trends of Mercury Usage in the United States and Florida

Rudolf and Janja Husar

These investigators, known for their insightful reconstruction of acid rain-promoting emissions and deposition, will apply similar approaches and methodology to the question of reconstruction of long-term, nationwide trends of mercury use and its subsequent fate in the environment. The analysis will be progressively refined in three phases. The first will assimilate mercury production, movement and usage data worldwide in order to perform a comprehensive analysis for the continental United States. The second and third phases will focus on Broward and Dade counties, respectively, in the State of Florida. This type of “emissions driver” analysis will be used in concert with the conventional emissions inventory described below to develop a detailed emissions trend for Florida for the past century. Completion of this analysis is anticipated in the third quarter of 2001.

South Florida Mercury Emissions Reconstruction, 1980 to 2000

Ralph Roberson

The goal of this analysis is reconstruction of a detailed emissions time trend covering more than just the incinerator sector in South Florida. RMB will perform a detailed emissions source inventory analysis of emissions from all types of sources in South Florida. Unlike a conventional emissions inventory, this effort will go beyond the typical methodology that focuses on existing databases. Rather, RMB will access annual operating reports and other onsite documentation available from the facilities or from the DEP regulatory reports and files. One element of this work will be to independently derive emissions factors from site specific data for each major facility over the period of this analysis. This will greatly enhance the accuracy and reliability of the resulting estimates.